

MONTHLY WEATHER REVIEW,

APRIL, 1877.

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

INTRODUCTION.

The present REVIEW for the month of April depends upon all data received up to the 15th of May from the Canadian Meteorological Service, the United States Signal Service and Voluntary Observers, the Army Post Surgeons and United States Navy. The most noticeable features recorded during the month are: the very severe storms off the Carolina coast from the 5th to the 14th; the general high temperature throughout the country; the excess of rain-fall in the South Atlantic States and Tennessee; the destructive hail-storms and tornadoes; the aurora of the 14th, visible from Dakota to Maine; the partial destruction of the grasshoppers west of the Mississippi by cold weather and snow, showing that the eastward migrations of these insects is probably limited by the vicissitudes of the climate of the Mississippi valley, whereby they are principally confined to the high, warm and dry plains that are not frequently visited by late cold weather and snows.

BAROMETRIC PRESSURE.

In General.—The general distribution of atmospheric pressure is shown by the isobars upon chart No. II, from which we see mean pressures of 30.00 or more reported from southern Florida, and from all Canadian stations. The area of lowest mean, 29.85 or less, extends from northern Texas to Nebraska. On the Pacific coast, 30.13 is reported from Portland, Or., and 30.01 from San Diego and San Francisco. Mean pressures east of the Rocky Mountains are from 0.05 to 0.20 less than during the cold months of April, 1874 and 1875, except in New Brunswick and Nova Scotia. In April, 1876, much higher pressures prevailed in the Southern States, and no marked area of high pressure appeared to exist north of the St. Lawrence and the Lakes.

Barometric Range.—The general range of the barometer over the whole country east of the Rocky Mountains was about 1.50 inches, as may be seen from the following table, which gives the maximum and minimum pressures that occur on the tri-daily maps, (7:35 a. m., 4:35 p. m. and 11 p. m., Washington time,) near the centres of the respective areas of high and low barometer:

AREA.		LOW AREAS.		HIGH AREAS.
No.	DATE.	MINIMUM BAROM.	DATE.	MAXIMUM BAROM.
I.	April 1st	29.28	April 1st	30.60
II.	" 5th	29.59	" 2d	30.57
III.	" 6th	29.26	" 8th	30.20
IV.	" 5th	29.70	" 9th	30.39
V.	" 8th	29.18	" 17th	30.24
VI.	" 18th	29.80	" 22d	30.45
VII.	" 18th	29.11	" 24th	30.37
VIII.	" 22d	29.70	" 30th	30.22
IX.	" 28th	29.40

The greatest local barometric ranges have been as follows: 1.37 in. at Leavenworth; 1.30 at Eastport; 1.27 at Duluth; 1.26 at Keokuk; 1.22 at Omaha; 1.21 at Yankton. The least local ranges have been: 0.39 at Pike's Peak; 0.72 at Cheyenne and Indianola, and 0.75 at Galveston.

Areas of High Pressure.—The areas of high pressure have presented no remarkable feature during the past month; they have extended somewhat to the north of their average position for this season; the average of the eight maximum pressures in the preceding table is 30.38, while the corresponding average for twelve areas during March was 30.40, showing but a slight change toward the conditions that prevail during the summer.

No. I.—Is the same as No. XII of March, and was central over the Gulf of St. Lawrence on the morning of the 1st. It disappeared in advance of low barometer No. I.

No. II.—Followed in the rear of low No. I, and was, on the 2nd, at 7:35 a. m., central in Minnesota; on the 3rd, 7:35 a. m., over Lake Huron; on the 4th, 7:35 a. m., over the mouth of the St. Lawrence.

No. III.—Followed in the rear of low No. V, and was, on the 6th, at 7:35 a. m., north of Minnesota, whence it moved southeastward, and was, on the 7th, at 7:35 a. m., central over Lake Huron, and during the next 24 hours remained nearly stationary.

No. IV.—Followed in the rear of low No. V, and was, on the 9th, at 7:35 a. m., central in Manitoba. During the next 24 hours, while extending southward, the eastward extension was also quite decided, and, on the 10th, 7:35 a. m., Nos. IV and III had united north of the Lake region, where cold, brisk northeast winds prevailed, while low area No. V continued near the South Atlantic coast. During the next 24 hours, while the pressure steadily increased in the Gulf States, Ohio valley and Northwest, the pressure also rose over the Lake region, with northeast winds, showing that here was the southern edge of a very extensive area of high pressure, which continued north of the Lake region until the 13th, 7:35 a. m., while the severe storm No. VI moved eastward over the Gulf States. During the 13th and 14th the pressure diminished over the Canadian stations, and the high pressure remained without definite limits.

No. V.—The passage eastward of low barometer No. VI was followed by southerly winds and rising barometer throughout the Gulf States, and the pressure remained high over Florida until the 18th, 7:35 a. m., after which it diminished, with southeast winds, while low No. VII moved eastward over the Ohio valley.

No. VI.—Followed in the rear of low No. VII but preceded No. VIII, and was formed by the flow southward of the intervening region of cool, dry air. It was, on the 21st, at 7:35 a. m., central over Lake Michigan, but extended as a barometric ridge southward to the Gulf. It moved slowly southeastward; on the 23rd, at 7:35 a. m., it extended as a ridge from Georgia to the St. Lawrence valley; during the rest of this day the pressure rapidly fell at the northern extremity, and what remained was, on the 24th, at 7:35 a. m., central in the East Gulf States.

No. VII.—Followed in the rear of low No. VIII, and, on the 24th, at 7:35 a. m., apparently extended as a ridge from Missouri northeastward to Manitoba; on the 25th, at 7:35 a. m., it extended over the Northwest and Lake region, and was central over Lake Michigan; on the 26th, 7:35 a. m., its southeastern extremity had covered the Middle States while the main body remained north of the Lake region, and was reinforced by an additional rise until low No. IX had reached the Missouri valley. On the 27th, 7:35 a. m., the area of high pressure evidently extended from the Lake region indefinitely to the northward. During the next 24 hours the pressure very generally fell over the Lakes and northward, but remained rather high over the St. Lawrence valley and Manitoba.

No. VIII.—Followed in the rear of low No. IX, and appears to have been mainly due to the south-eastward flow of dry, cool air over the eastern slope of the Rocky mountains. It remained during the 29th and 30th central over the Southwest and Western Gulf States extending slowly eastward.

Areas of Low Pressure.—No. I.—The early history of this depression is given in the WEATHER REVIEW for March as area No. XII. It was central on the 1st of April, at 7:35 a. m., in western Minnesota, whence it moved nearly due eastward over the Lake region and Canada, and on reaching New England its nearly circular centre had changed to a rather long trough trending nearly north and south. The central pressure on the 1st, 7:35 a. m., was 29.28, but on the 2nd, 7:35 a. m., 29.92. The storm appears to have been broken up over New England, and was immediately followed by high barometer No. II. A tornado passed over Barry county, Missouri, about 5 p. m. of March 31st; it moved from the SW. to the NE., and its central portion was seen to be funnel-shaped, twisting spirally upward, and moving forward with great velocity. The central path of destructive winds was about 500 feet wide.

No. II.—This depression was central on the 2nd, 11 p. m., northwest of Dakota, having been preceded by a depression in Oregon; it moved eastward over the Lake region, being central on the 4th, 7:35 a. m., in northwestern Wisconsin on the 5th, 7:35 a. m., over Lake Huron. During the rest of this day this depression extended in all directions, and became merged into No. III, which was at that time moving northeastward along the Atlantic coast.

No. III.—An extensive area of cool northeasterly winds prevailed on the 3rd throughout the Gulf States, Ohio valley and Lower Lakes, followed during the afternoon and evening by increasing cloudiness and light rains. Some information in regard to the condition of the atmosphere is furnished by the observations made on the occasion of a balloon ascension at Nashville, the details of which are given in the accompanying diagram, from which, and other records, it appears that a gentle, moist current, at about the rate of four miles per hour from the N.E., prevailed at the earth's surface over all the neighboring region. This current at Nashville prevailed up to altitudes varying between 2,500 and 3,100 feet above sea-level, or 2,000 and 2,600 above the Signal Service station. At these altitudes the balloon passed into a diametrically opposite cold and dry current, moving at the rate of 20 miles per hour, from the SW. The balloon ascended only about 5,200 feet, (barometer 25.50,) and the southwest current still existed at that height. Cirro-stratus clouds covered the heavens during the whole ascension, and were always above the balloon; this cloud stratum seems to have steadily increased from a haze in the morning to dense stratus at night, followed by rain at 11 p. m. The direction of its movement was from the SW., as observed at all the stations in Tennessee and Kentucky. The condition of the atmosphere at different levels is best seen by grouping the observations according to the altitudes at which they are taken. We thus obtain the following numbers:

STATIONS.	No. of Observations.	Time.	Barometer.	Thermometer.		Approximate altitude.	Ten. Vap.	Dew Point.	Relative Humidity.
				Dry.	Wet.				
I. In Balloon.....	10	P. M. 4:27	25.132	46.55	33.20	4,820	0.0460	-0.2	12
II. In Balloon.....	6	3:35	27.178	52.18	42.67	2,700	0.1603	+28.6	41
III. In Balloon.....	1	5:21	28.450	51.50	42.5	1,440	0.159	28.9	42
	10	3:39	28.632	55.00	46.00	1,280	0.1605	32.8	44
IV. In Balloon.....	20	4:03	29.335	56.10	47.30	620	0.197-	36.0	47
V. { Signal Service Station, Nashville. }	1	2:00	29.499	55.-	45.-	-	0.168-	30.-	39
	1	3:56	29.462	57.-	46.-	504.2	0.166-	30.-	36
	1	9:00	29.416	53.-	48.-	-	0.263-	42.-	67
VI. *Reduced to sea-level.....	1	3:56	29.990	-	-	0	-	-	-

The group II represents the temperature, pressure, &c., prevailing near the upper limit of the lower or warm, moist, gentle northeast current. Group I shows the conditions in the cold, dry and more rapid southwest current next above; the thickness of this strata we have no means of determining further than that the cirro-stratus clouds and haze, that at 5,200 feet were still above the balloon, were moving with it from the southwest, and, therefore, probably formed a part of it.

The general depression thus formed over so large an area was on the 4th, 7:35 a. m., central over northern Florida, whence the area of lowest pressure moved eastward to the Atlantic coast, after which it turned northeast, being central on the 5th, 7:35 a. m., off Cape Hatteras. During the rest of this day the barometer fell rapidly over New England and the storm-centre apparently turned northward in its course, being at 11 p. m., of the 5th, central near the coast of Maine, where it remained nearly stationary during the night. Its centre passed during the 6th very slowly over Maine and New Brunswick, and during the 7th equally slowly over Nova Scotia, east of which province it was central on the 7th, at 11 p. m.

Nos. IV and V.—The pressure fell rapidly at Manitoba between 4:35 and 11 p. m. of the 4th, and slightly in Oregon, where the barometer was quite high. The depression in Manitoba was rapidly followed by northwest winds and rising barometer, which latter extended rapidly southward into Kansas, where a new depression (No. V) was formed, during the 5th, between the areas of cold northerly and warm southerly winds. On the 5th, 4:35 p. m., No. IV was central north of the Lake region, while No. V was in Kansas. The former depression was now lost sight of, while the latter rapidly increased, after first moving southward into Texas, where it developed during the 6th and 7th. During the interval the extensive area of high pressure No. III moved southeastward over the Lake region and Middle States, followed by a decided depression, which rapidly stretched southward from Manitoba to Texas during the 7th, and seems to have led the way in the northward movement of area No. V, which was, on the 7th, 4:35 p. m., apparently central in Indian Territory, with a tendency to the formation of a new centre about 300 miles to the eastward. At 11 p. m. of 7th the lowest pressure was central in Mississippi, and undoubtedly represents the eastern division just referred to, whose development was attended by the tornado described further on. Its path is thence northward into Tennessee and eastward to the Carolina coast, where a slight depression existed on the 9th, 7:35 a. m., where the barometer remained low during the rest of the day, while brisk and high northeast winds prevailed along the Middle and East Atlantic coasts, and it seems likely that a well-defined, severe storm was developed at some distance off the coast, and moved northeastward, passing to the east of Nova Scotia at about 11 p. m. of 11th. At 4 p. m. of the 7th, while the centre of lowest pressure was in Indian Territory, a severe tornado passed over De Soto county, Louisiana. Later in the night another tornado

passed northward over Pensacola, Florida into Alabama, developing rapidly into a new area of low pressure. The destruction of property and life at Pensacola was severely felt; this storm began, with a strong SE. wind, at 2 p. m.; at 9 a. m. a very heavy rain began, partially ceasing at midnight; between 3 and 4 a. m. of the 8th the wind veered suddenly to a violent SW. gale, lasting only five minutes, but doing much damage. While the area of lowest pressure continued, during the 8th, west of the Blue Ridge mountains, the southward flow of air along the Atlantic coast produced violent gales on the North Carolina coast. At Cape Henry a wind of 65 miles per hour prevailed for 38 hours, and thence to Cape Hatteras, the storm is described as one of rare severity during the 8th and 9th. The schooner *Clara E. Bergen*, from Charleston for New York, encountered the gale of the 8th and hurricane of the 9th and 10th off Cape Hatteras, experiencing the highest winds at 8 a. m. of the 10th. The winds were from ENE. to SE.

No. VI.—The barometer began to fall in California on the 9th, and was lowest on the 10th, at 4:35 p. m. The subsequent depression at the Rocky Mountain stations continued into the 11th, the pressure being lowest at Santa Fe at 7:35 a. m. An area of low pressure was developed in Texas between the 11th, 4:35 p. m. and 12th, 7:35 a. m., and was, at the latter date, central in western Louisiana, but extended as a trough southeastward to Panama, where the pressure was 29.81, while it was about 29.70 at Aspinwall and 29.50 at Vera Cruz. By this time high northerly winds had swept down over Texas, and southeast winds, with rain, prevailed in the Eastern Gulf States. The area of lowest pressure moved thence southeastward into the Gulf of Mexico and then turning northeastward passed over Georgia to the coast of South Carolina. It was, on the 13th, at 11 p. m., central some distance east of the coast, whence it moved to the east-northeast beyond our stations. The U. S. S. *Powhatan*, was at 7:35, 14th, near its centre, with barometer 29.25, and a NNE. hurricane, being in latitude $34^{\circ} 20'$, longitude $76^{\circ} 25'$. In its passage over the South Atlantic States this storm developed into one of hurricane violence, and is described as such by vessels encountering it on the ocean. At Charleston on April 13th the wind increased from 2 a. m. to 5 a. m., when it had attained 36 miles per hour, and to a maximum, at 8 a. m., of 55 miles from northeast. This wind-velocity and the rain-fall of 6 inches between 3:30 and 8:20 a. m. has not been equalled before since the establishment of the Charleston station. The steamship *Gulf Stream* left Charleston, April 12th, 5:40 a. m., for New York. On Friday, April 13th, 4:30 a. m., when off Cape Lookout Shoals, the wind having become dangerous, the vessel steamed eastward; by 5 p. m. the wind had increased to a full hurricane velocity from the northeast, and the vessel, being about 100 miles off the coast scudded, before the wind receiving also considerable damage. The barometer continued at 29.30 and less from 5 p. m. of 13th to 2 a. m. of the 14th when the barometer had passed its lowest reading; the wind seems to have been due northeast. The steamers *G. W. Clyde*, from New York to Charleston, and *General Barnes*, from Savannah for New York, encountered the same storm in about the same location.

No. VII.—The barometer fell rapidly during the 13th and 14th in Oregon, and a considerable depression was on the 14th, 4:35 p. m., apparently central in Manitoba, whence it extended southward without any definite existence as a storm-centre until the 16th, 4:35 p. m., by which time the pressure had begun to rise rapidly in Manitoba and Oregon, and the area of lowest barometer was probably central in southern Dakota. After moving southward into Nebraska and thence eastward to Iowa, the depression then began to extend north and south into an oval, which, on the 18th, was again contracted into a well-defined storm centre, which was, at 11 p. m. of 18th, central, with a very low pressure, in Western Missouri: tornadoes passed from Missouri eastward into Tennessee this night, and are reported from Union City, Laverne and Viola, Tenn. and Holly Spring, Miss. At this time the area of southwest winds and cloud or rain extended over the Eastern Gulf and South Atlantic States; southeast winds and rain in the Ohio valley and portions of the Missouri valley; northeast winds with rain over the Middle and Eastern States, Lake region and Upper Mississippi valley. These weather conditions continued during the night, and greater part of the 19th, while the lowest pressure moved slowly eastward into the Ohio valley, where it was central on the 19th, at 11 p. m. The lowest isobars then began to stretch as a barometric trough along the line of the Alleghanies. On the 20th, at 4:35 p. m., the lowest pressure was central in Massachusetts, whence it moved northeastward along the coast of Maine and disappeared over the Gulf of St. Lawrence, on the morning of the 21st. At St. John, New Brunswick, on the 20th, a severe east gale prevailed in the early morning, proving very destructive to the shipping in the harbor.

Nos. VIII.—This depression follows immediately in the rear of high barometer No. VI, and is first well located on the 21st, 4:35 p. m., as a very long oval trending north and south through Dakota and Manitoba. The northwest winds in its rear closed in upon it by 4:35 p. m. of the 22nd, at which date an oval, central in northeastern Nebraska, represents what there was left of the original depression. This oval seems to have at once begun a rapid movement northeastward, and disappeared on the 23rd, 4:35 p. m., north of Lake Superior; meanwhile the cold northerly winds in their progress southward gave rise to a second depression in western Texas, which became merged into No. IX.

No. IX.—This depression appears to have originated in the precipitation that took place at the south-

western stations on the 24th. During this day the pressure fell on the Pacific coast and at all the Rocky Mountain stations, and an area of high pressure consequently moved southward over the Lake region and the Northwest, while southeasterly winds prevailed in the Gulf States. The area of precipitation extended, during the 25th, northward into Wyoming Territory and Nebraska, and on the 26th into Dakota, while the pressure continually fell in the Southwest, but rose north of Illinois and Iowa. On the 26th, 4:35 p. m., the lowest pressure was central in the southwestern part of Indian Territory, and severe hail-storms, with winds of tornado violence, occurred in Red river and Travis counties, Texas, during the evening. The storm-centre moved thence eastward and northward, and was, on the 27th, at 4:35 p. m., central from the southwestern corner of Nebraska to St. Louis, along the Missouri valley. The axis of the oval, which at this time trended east and west, so continued during the 23th, while the area of lowest pressure moved eastward into Ohio and thence northeast over the Lower Lake region. During the 29th two areas were formed, which were central, at 4:35 p. m., respectively, in northern Michigan and Pennsylvania—the latter moved southeastward to the Atlantic coast, and pressure remained very generally low over the Middle and Eastern States and Lower Lakes, with cloudy and rainy weather, but without any well-defined lowest pressure during the 29th and 30th.

Vessels experiencing storms at sea.—Besides the almost continuous gales that prevailed off the coast of the Carolinas and Virginia from the 5th to the 14th, the following notes relating to more distant storms have been received. On the 6th, lat. $29^{\circ} 40' N.$, long. $68^{\circ} 00' W.$, heavy SE to NE gale; 9th, $27^{\circ} 21'$, $75^{\circ} 03'$, heavy ENE to NNE gale; 9th to 13th, lat. 27° to 37° , long. 73° to 76° , heavy gale; 10th, lat. 35° to 34° , long. 71° , SE gale backing to NE; 11th, lat. 34° , long. 42° , strong W gale; 12th, off coast of Cuba, severe SE gale; 13th, lat. $42^{\circ} 13'$, long. $62^{\circ} 04'$, strong NW to N gale; 13th to 15th, lat. $24^{\circ} N.$, long. $73^{\circ} W.$, heavy WSW to WNW gale; 18th, lat. 36° , long. 67° , heavy SW gale.

TEMPERATURE OF THE AIR.

The general distribution of temperature is shown by the isotherms on Chart No. II. The comparison with the mean temperatures, observed at Signal Service Stations since 1870, is given in the small table upon the same chart, and shows temperatures above the average, excepting in the South Atlantic and Gulf States. The isotherm of 70° passes from Indianola, Tex., to the northern portion of the peninsula of Florida; its course is the same as in April, '76, but is $3^{\circ} N.$ of its position in April, '75, and 2° to $3^{\circ} N.$ of its position in April, '74; the isotherm of 40° passes through Bismarck, Duluth, Lake Huron, Quebec, Halifax, and its course is the same as in April, '76, but is $5^{\circ} N.$ of its position in April, '75, and 5° to $7^{\circ} N.$ of its position in April, '74. The following monthly means have been received since the chart was printed: Pembina, $33^{\circ}.1$, Virginia City, $36^{\circ}.5$, Fort Sully, $44^{\circ}.7$, and Cape Hatteras, $55^{\circ}.2$.

Maximum and Minimum Temperatures.—The *maxima* above 80° were: 91° at Indianola on the 7th. 88° Boerne, 4th. 87° San Antonio, 4th and 7th. 86° Tybee Island, 25th. 85° Augusta, 24th and 25th; Charleston, 24th; Jacksonville and Savannah, 20th; Wilmington, 24th. 84° Corsicana, 21st; Lynchburg, 24th. 83° Fort Gibson, 5th; Knoxville, 24th; Mobile, 28th; Norfolk and Shreveport, 6th. 82° Galveston, 20th; Louisville, 23rd; Montgomery, 25th; St. Mark's, 22nd; Washington, 24th. 81° Denison, 7th; Marquette and New York, 24th; St. Louis, 23rd; Vicksburg, 22nd. The *maxima* below 70° were: 68° at Barnegat, 25th; Wood's Holl, 24th. 66° Bismarck, 30th. 67° Breckenridge, 21st; Cheyenne, 20th; Santa Fe, 15th. 64° Buffalo, 23rd. 63° Duluth, 25th; Eastport, 23rd and 27th; Thatcher's Island, 26th. 61° Alpena, 20th and 22nd; Escanaba, 23rd. 49° Mount Washington, 24th. 26° Pike's Peak, 26th. The *minima* above 40° were: 42° at Augusta, 12th and 15th; Corsicana, 2nd; Savannah, 14th. 43° Charleston, 10th; Tybee Island, 14th. 45° Jacksonville and St. Mark's, 15th. 46° Montgomery, 5th. 47° San Antonio, —. 48° Shreveport, 2nd. 49° Mobile, 14th; Vicksburg, 3rd. 54° Galveston, 24th. 55° Indianola, 30th; New Orleans, 13th and 15th. The *minima* below 10° were: 9° at Cheyenne, 29th; St. Paul, 2nd. 5° Duluth, 2nd; Mt. Washington, 7th and 12th. 3° Breckenridge, 1st. 2° Bismarck, 2nd. -8° Pike's Peak, 29th.

Ranges of Temperature.—The largest *diurnal* ranges are as follows: 40° at Denver, 30th; 41° Boerne, 20th; 42° Leavenworth, 5th; 38° Cheyenne, 29th, Dodge City, 6th, Morgantown, 16th, Yankton 22nd; 39° Fort Gibson, 5th, Lynchburg, 24th, Marquette, —. The largest *monthly* ranges are: 60° at Denver; 61° La Crosse; 64° Bismarck, Breckenridge and St. Paul; 69° Marquette. The smallest *monthly* ranges are— 33° at Thatcher's Island; 34° Mobile and Pikes Peak; 35° Eastport and Shreveport; 36° Barnegat, Cape Lookout, Indianola, Montgomery and Wood's Holl; 25° New Orleans; 28° Galveston; 32° Vicksburg.

Frosts.—On the 2nd, in Ill., Tenn. 3rd, Ill., Md., Va. 7th, Md. 10th, Ark., N. C., Tex., Utah. 11th, Md., N. C., Va. 13th, Va. 14th, Ark., Va. 15th, Md., N. C., S. C., Va. 16th, N. C. 25th, Iowa. 26th, N. Y. 29th, Ill., Ind. Ty. 30th, Kan., Ark., Ill., Ind., Neb., Tenn., Ind. Ty., Mo.

Ice.—The occurrence of cold, dry nights, marked by the formation of ice rather than frost, is noted on the following dates: 4th, Utah; 9th, Utah; 11th, Va.; 12th, N. C.; 18th, 19th, 20th, 21st, 22nd, 23rd, Utah; 24th, Iowa, Utah; 27th and 28th, Utah; 29th, Kan., Neb.; 30th, Ill., Kan., Neb.